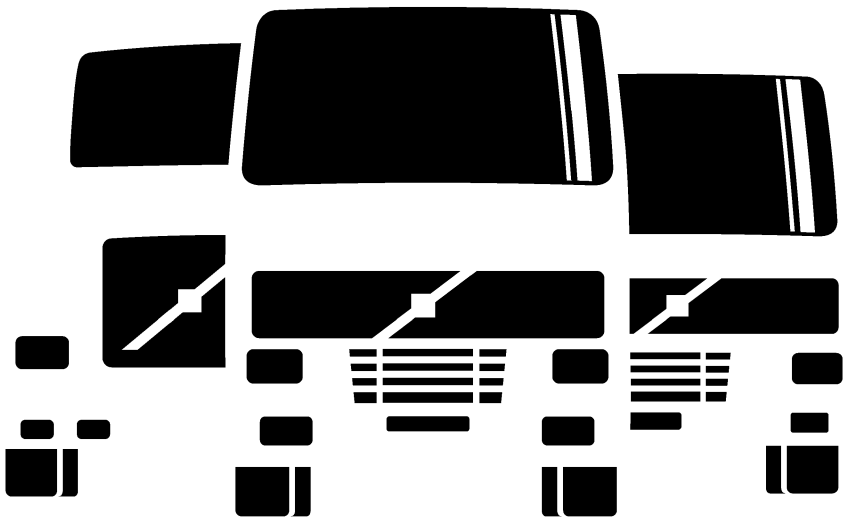
Service Manual
Trucks

Group **200-820**

Specifications

VE D12



V776-200-820SM

VOLVO

Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to August 95.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to an S.R.T. (Standard Repair Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to an S.R.T.

The following levels of observations, cautions and warnings are used in this Service Documentation:

Note: Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

Caution: Indicates an unsafe practice where damage to the product could occur.

Warning: Indicates an unsafe practice where personal injury or severe damage to the product could occur.

Danger: Indicates an unsafe practice where serious personal injury or death could occur.

Volvo Trucks North America, Inc.
Greensboro, NC USA

Order number: V776-200-820SM

Contents

Specifications

Engine

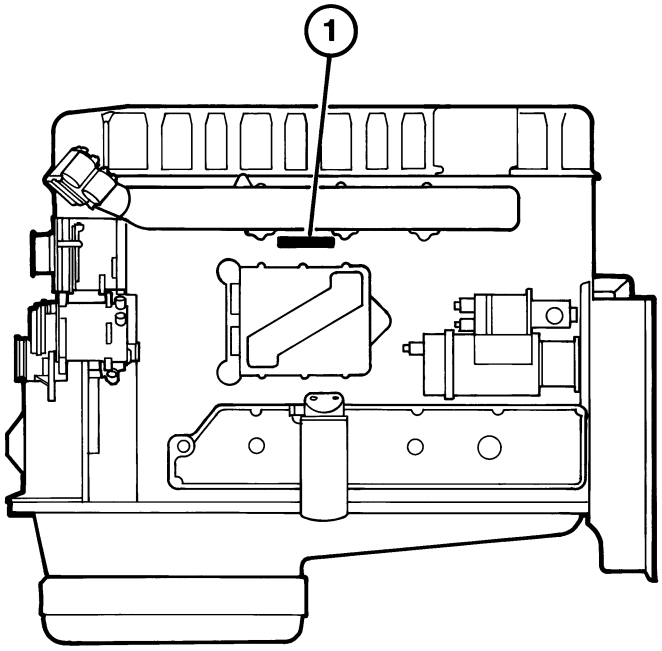


Fig. 1: VE D12 Engine

1 Serial Number Location

Model Designations

VE D12–310

Max. Power ..... 232 kW (310 Hp) @ 1700 rpm

Max. Torque .... 1694 Nm (1254 lb-ft) @ 1100-1300 rpm

VE D12–335

Max. Power ..... 259 kW (335 Hp) @ 1700 rpm

Max. Torque .... 1762 Nm (1304 lb-ft) @ 1100-1300 rpm

VE D12–370

Max. Power ..... 276 kW (370 Hp) @ 1700 rpm

Max. Torque .... 1762 Nm (1304 lb-ft) @ 1100-1400 rpm

VE D12–415

Max. Power ..... 310 kW (415 Hp) @ 1700 rpm

Max. Torque .... 1850 Nm (1369 ft-lb) @ 1100-1500 rpm

Number of Cylinders	6
Number of Valves	24 per Cylinder
Bore 131 mm	(5.2 in)
Stroke 150 mm	(5.9 in)
Displacement	12 Liters (740 in^3)
Compression Ratio	17.5:1
Firing Sequence	1-5-3-6-2-4
Low Idle	500-650 rpm
High Idle	2065 ± 20 rpm
Maximum Full Load Speed	1900 rpm
Weight, Engine With Flywheel, Flywheel Housing and Starter Motor (Dry)	1060 kg (2332 lb)
Length	1348 mm (53 in)
Width	780 mm (30.7 in)
Height	1138 mm (44.8 in)

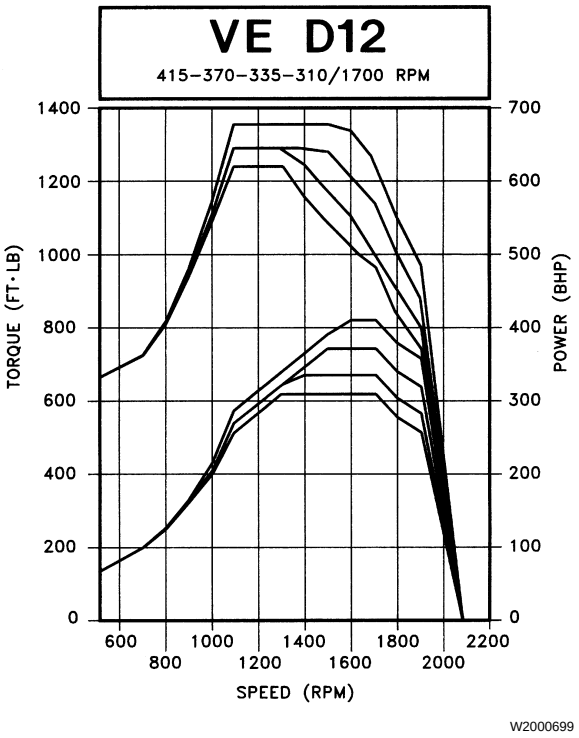


Fig. 2: Performance curves

Cylinder Head

Type	6 cylinder
Length	1076 mm (42.36 in)
Width	373 mm (14.68 in)
Height	135 mm (5.31 in)

Cylinder Head Bolts

Number	38
Thread size	M16
Length	200 mm (7.87 in)

Cylinder Block

Height above block face, crankshaft center (**A**) minimum	422 mm (16.61 in)
Height, lower block face, crankshaft center (**B**) minimum	120 mm (4.72 in)

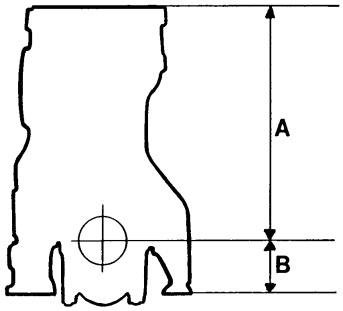


Fig. 3: Cylinder block

Cylinder Liner

Type	Wet, replaceable
Sealing surface height above face	0.15–0.20 mm (0.0059–0.0078 in)
Number of O-rings, cylinder liner	4

Piston

Height above cylinder block face	0.15–0.65 mm (0.0059–0.0255 in)
Diameter, combustion chamber	86 mm (3.38 in)
Depth, piston ball	19.7 mm (0.775 in)
Number of ring grooves	3
Front marking	Arrow pointing forward

Piston Rings, Compression

Number	2
Piston ring clearance in groove:	
Upper compression ring	Keystone
Lower compression ring	0.070–0.102 mm (0.0027–0.004 in)
Piston ring gap measured in ring opening:	
Upper ring	0.40–0.65 mm (0.015–0.0255 in)
Lower ring	0.8–1.0 mm (0.031–0.039 in)

Piston Rings, Oil Control Ring

Number	1
Width, including spring	4.88 mm (0.192 in)
Piston ring clearance in groove	0.050–0.082 mm (0.0019–0.0032 in)
Piston ring gap measured in ring opening	0.40–0.75 mm (0.0157–0.0295 in)

Valves, VE D12

Valve disc diameter:	
Intake	40 ± 0.1 mm (1.57 ± 0.0039 in)
Exhaust	40 ± 0.1 mm (1.57 ± 0.0039 in)
Valve stem diameter:	
Intake	7.964–7.975 mm (0.3135–0.3140 in)
Exhaust	7.951–7.962 mm (0.313–0.3135 in)
Valve seat angle:	
Intake	29.5°
Exhaust	44.5°
Valve disc edge:	
Intake	1.76 mm (0.069 in)
Exhaust	1.57 mm (0.061 in)
Seat angle in cylinder head:	
Intake	30°
Exhaust	45°

Valve clearance, cold engine, setting value:	
Intake	0.2 mm (0.0078 in)
Exhaust	0.5 mm (0.0196 in)
Exhaust, VEB	1.6 mm (0.0629 in)
Valve clearance, cold engine, checking value:	
Intake	0.15–0.25 mm (0.0059–0.0098 in)
Exhaust	0.45–0.55 mm (0.0177–0.0216 in)
Exhaust, VEB	1.55–1.65 mm (0.061–0.065 in)

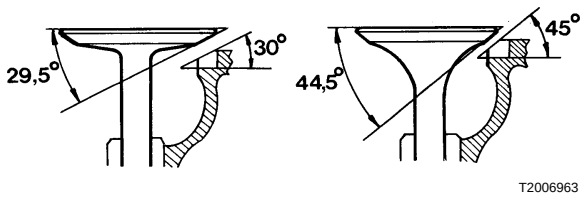


Fig. 4: Valve angles

Valve Seats

Outer diameter Standard (measurement **A**:	
Intake	43.070–43.086 mm (1.695–1.696 in)
Exhaust	43.070–43.086 mm (1.695–1.696 in)
Oversize:	
Intake	43.270–43.286 mm (1.703–1.704 in)
Exhaust	43.270–43.286 mm (1.703–1.704 in)
Height (measurement **B**):	
Intake	8.5–8.7 mm (0.335–0.343 in)

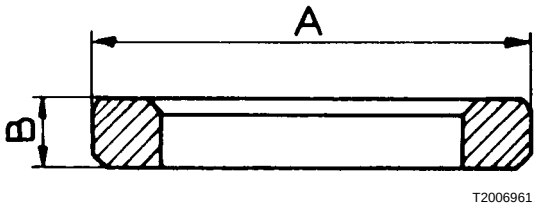


Fig. 5: Valve seats

Valve Seat Location

Diameter standard (measurement **C**):	
Intake	43.000–43.025 mm (1.693–1.694 in)
Exhaust	43.000–43.025 mm (1.693–1.694 in)
Diameter oversize (measurement **C**):	
Intake	43.200–43.225 mm (1.701–1.702 in)
Exhaust	43.200–43.225 mm (1.701–1.702 in)
Depth (measurement **D**):	
Intake	11.2 ± 0.1 mm (0.44 ± 0.004 in)
Exhaust	11.2 ± 0.1 mm (0.44 ± 0.004 in)
Seat bottom radius (measurement **R**):	
Intake, maximum	0.8 mm (0.03 in)
Exhaust, maximum	0.8 mm (0.03 in)
Measurement between valve disc and cylinder head face:	
Intake	0.9–1.4 mm (0.035–0.055 in)
Exhaust	1.2–1.7 mm (0.047–0.067 in)

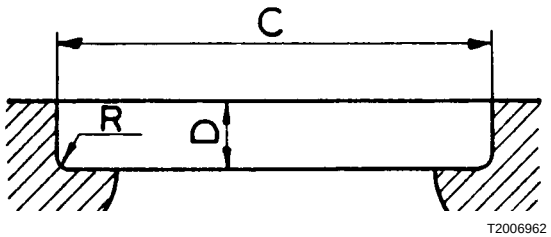


Fig. 6: Valve seat location

Valve Guides

Length:	
Intake	83.2–83.5 mm (3.28–3.29 in)
Exhaust	83.2–83.5 mm (3.28–3.29 in)
Inner diameter:	
Intake	8.000–8.015 mm (0.315–0.316 in)
Exhaust	8.000–8.015 mm (0.315–0.316 in)
Height above cylinder head spring face:	
Intake	26.5 ± 0.35 mm (1.0 ± 0.01 in)
Exhaust	18.5 ± 0.35 mm (0.73 ± 0.01 in)
Clearance valve stem-guide:	
Intake	0.025–0.051 mm (0.0009–0.003 in)
Exhaust	0.038–0.064 mm (0.001–0.003 in)
Rocker arms:	
Bearing clearance	0.03–0.08 mm (0.001–0.003 in)

Valve Springs, Exhaust

Outer valve spring:	
Length, unloaded	72.4 mm (2.85 in)
With load of 600 Nm (135 ft-lb)	55.9 mm (2.2 in)
With load of 1076 Nm (242 ft-lb)	42.8 mm (1.68 in)
Rigid length, maximum	41.2 mm (1.62 in)
Inner valve spring:	
Length, unloaded	67.5 mm (2.65 in)
With load of 243 Nm (55 ft-lb)	51.9 mm (2.04 in)
With load of 447 Nm (100 ft-lb)	38.8 mm (1.52 in)
Rigid length, maximum	35.7 mm (1.40 in)

Valve Springs, Intake

Length, unloaded	72.4 mm (2.85 in)
With load of 600 Nm (135 lb-ft)	55.9 mm (2.2 in)
With load of 1076 Nm (242 lb-ft)	42.8 mm (1.68 in)
Rigid length, maximum	41.2 mm (1.62 in)

Timing Gears

Ref. No.	Description	No. of Teeth
1	Crankshaft Drive Gear	36
2	Idler Gear	87
3	Water Pump Drive Gear	24
4	Air Compressor Drive Gear	27
5	Camshaft	72
6	Adjustable Idler Gear	58
7	Upper Idler Gear	60
8	Lower Idler Gear	58
9	Power Steering Pump Drive Gear	22
10	Drive Gear Arrangement (Accessory Drive Pulley and Fuel Feed Pump)	26
11	Power Take-Off (PTO) Idler Gear	87
12	Power Take-Off (PTO) Drive Gear for Hydraulic Pump	37
13	Oil Pump Drive Gear	24
14	Oil Pump Idler Gear	57

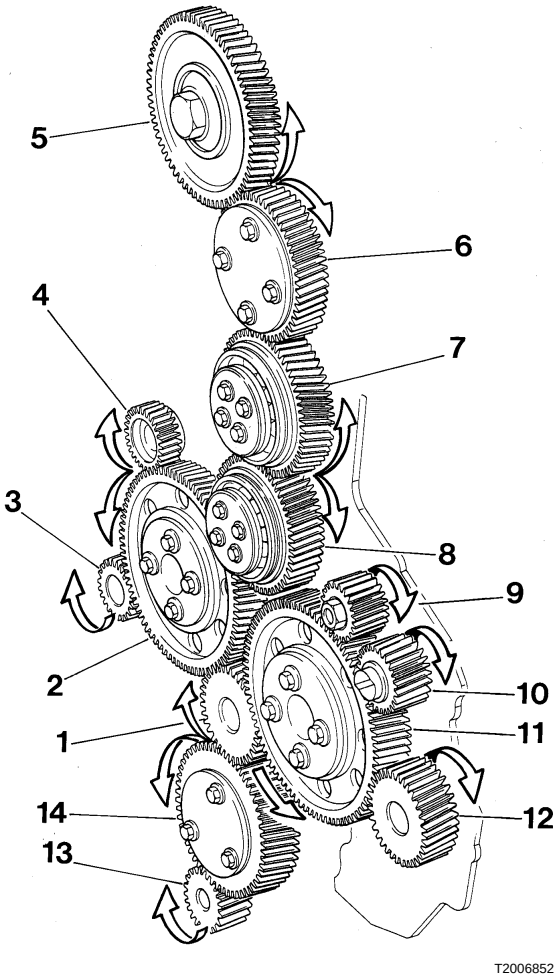


Fig. 7: Timing gear arrangement

Backlash	0.05–0.17 mm (0.0017–0.0067 in)
Axle journal for intermediate gear, diameter	99.989 ± 0.011 mm (3.9 ± 0.0004 in)
Bushing for intermediate gear, diameter	100.037 ± 0.011 mm (3.94 ± 0.0004 in)
Radial clearance for intermediate gear	0.026–0.070 mm (0.001–0.003 in)
Axial clearance for intermediate gear	0.05–0.15 mm (0.002–0.006 in)

Camshaft

Drive	Gear
Number of bearings	7
Diameter, bearing journals, minimum:	
1st, and 2nd, 7th bearing pin	70–0.030 mm (2.8–0.001 in)
Check of camshaft setting (cold engine and 0 valve clearance):	
1 With flywheel at 6° ATDC, the intake valve for no. 1 cylinder must have opened 1.6 mm (0.06 in). 2 During this check, the timing gears must be turned clockwise (viewed from the front) to take up any tolerances.	
Valve lift, maximum:	
Intake	13.1 mm (0.5 in)
Exhaust	13.1 mm (0.5 in)
Electronic unit injectors:	
Maximum stroke	15 mm (0.6 in)

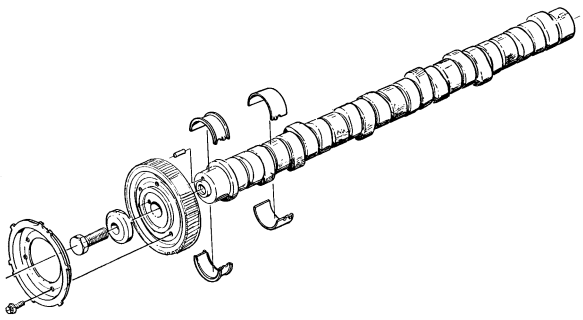


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Fig. 8: Camshaft and bearings

Camshaft Bearings

Diameter, camshaft bearing housing:	
1st bearing	73.9 ± 0.013 mm (2.9 ± 0.0005 in)
2nd–7th bearings	73.9 ± 0.013 mm (2.9 ± 0.0005 in)

Crankshaft

Length	1202.8 mm (47.35 in)
Crankshaft axial clearance	0.07–0.31 mm (0.0027–0.012 in)
Main bearing, radial clearance	0.044–0.121 mm (0.001–0.0048 in)

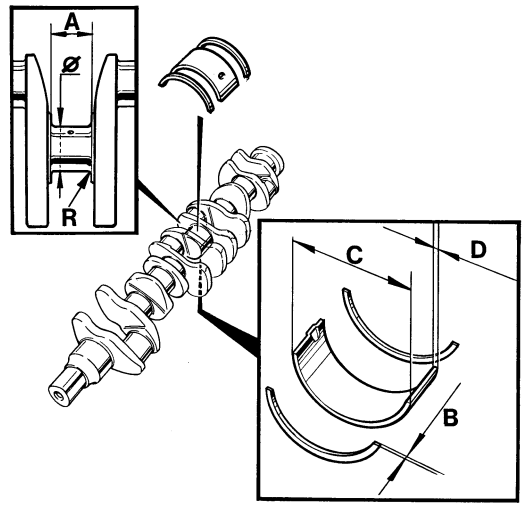

Fig. 9: Crankshaft and bearings

Main Bearing Journals

Diameter for machining, standard	107.978–108.000 mm (4.251–4.252 in)
Undersize:	
0.25 mm	107.728–107.75 mm (4.241–4.242 in)
0.50 mm	107.478–107.50 mm (4.231–4.232 in)
0.75 mm	107.228–107.25 mm (4.221–4.222 in)
1.00 mm	106.978–107.00 mm (4.211–4.212 in)
1.25 mm	106.728–106.75 mm (4.201–4.202 in)
Surface finish, main bearing pin	Ra 0.25
Surface finish, radius	Ra 0.40
Width, axial bearing pin (**A**) standard	46.975–47.025 mm (1.849–1.851 in)

Oversize:	
0.2 mm (axial bearing 0.1)	46.575–46.625 mm (1.833–1.835 in)
0.4 mm (axial bearing 0.2)	46.375–46.425 mm (1.825–1.827 in)
0.6 mm (axial bearing 0.3)	46.375–46.425 mm (1.825–1.827 in)
Fillet radius (**B**)	3.75–4.00 mm (0.147–0.157 in)

Thrust Washers (Axial Bearing)

Width (**B**) standard	3.140–3.210 mm (0.123–0.126 in)
Oversize:	
0.1 mm (0.004 in)	3.240–3.310 mm (0.127–0.130 in)
0.2 mm (0.008 in)	3.340–3.410 mm (0.131–0.134 in)
0.3 mm (0.012 in)	3.440–3.510 mm (0.135–0.138 in)

Main Bearings

Type	Replaceable
Outer diameter (**C**)	113.065 mm (4.45 in)
Thickness (**D**) standard	2.483–2.498 mm (0.097–0.098 in)
Oversize:	
0.25 mm (0.01 in)	2.608–2.623 mm (0.102–0.103 in)
0.50 mm (0.02 in)	2.733–2.748 mm (0.107–0.108 in)
0.75 mm (0.03 in)	2.858–2.873 mm (0.0112–0.0113 in)
1.00 mm (0.04 in)	2.983–2.998 mm (0.1174–0.1180 in)
1.25 mm (0.05 in)	3.108–3.123 mm (0.1223–0.1229 in)

Connecting Rods

Length, center (**E**)	260 ± 0.05 mm (10.2 ± 0.002 in)
Marking:	
Connecting rod resp. cap	1 to 6
FRONT on rod turned	Forward
Connecting rod bushing bore (**G**)	55 + 0.028 + 0.022 mm (2.16 + 0.001 + 0.0008 in)
Axial clearance, connecting rod, crankshaft:	
Maximum	35 mm (0.013 in)
Minimum	0.15 mm (0.006 in)
Connecting rod bearing, radial clearance:	
Maximum	0.102 mm (0.004 in)
Minimum	0.045 mm (0.001 in)

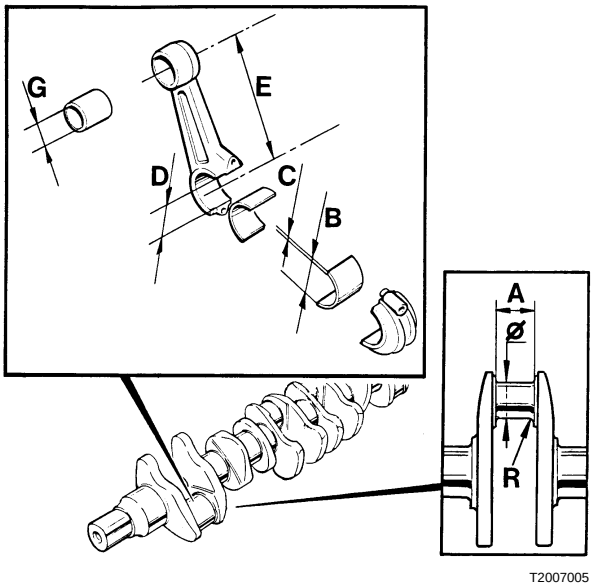

Fig. 10: Connecting rod dimensions

Connecting Rod Bearing Journals

Diameter (⌀) for machining, standard	91.978–92.000 mm (3.621–3.622 in)
Undersize:	
0.25 mm (0.01 in)	91.728–91.750 mm (3.6113–3.6122 in)
0.50 mm (0.02 in)	91.478–91.500 mm (3.601–3.602 in)
0.75 mm (0.03 in)	91.228–91.250 mm (3.591–3.592 in)
1.00 mm (0.04 in)	90.978–91.000 mm (3.581–3.582 in)
1.25 mm (0.05 in)	90.728–90.750 mm (3.571–3.572 in)
Surface finish, connecting rod bearing pin	Ra 0.25
Surface finish, radius	Ra 0.4
Width (**A**) axial bearing pin	56.9–57.0 mm (2.240–2.244 in)
Fillet radius (**D**) (5.25–5.5)	3.75–4.00 mm (0.1476–0.1574 in)

Connecting Rod Bearings

Outer diameter (**B**)	96.85 mm (3.81 in)
Thickness (**C**) standard	2.385–2.395 mm (0.0938–0.0942 in)
Oversize:	
0.25 mm (1.0 in)	2.510–2.520 mm (0.0988–0.0992 in)
0.50 mm (0.02 in)	2.635–2.645 mm (0.103–0.104 in)
0.75 mm (0.03 in)	2.760–2.770 mm (0.1086–0.1090 in)
1.00 mm (0.04 in)	2.885–2.895 mm (0.1135–0.1139 in)
1.25 mm (0.05 in)	3.010–3.020 mm (0.1185–0.1188 in)
Diameter, bearing seat (**D**)	96.835–96.850 mm (3.812–3.8129 in)

Flywheel

Maximum allowable axial throw (manual transmission) measuring radius 150 mm (5.9 in)	0.20 mm (0.0079 in)
Number of teeth on flywheel	153

Flywheel Housing

Maximum allowable axial throw for contact surface against bell housing	0.20 mm (0.0079 in)
Maximum allowable radial throw for positioning against bell housing	0.25 mm (0.0098 in)

Lubrication and Oil System

Oil

Heavy duty engine oil to API-CD/CE or CF-4 specifications. For extended oil drain intervals, the oil must also meet Volvo Drain Specifications (VDS).

Oil Pressure

Operating speed	300–550 kPa (44–80 psi)
Idle speed, minimum	150 kPa (22 psi)

Lube Oil Pump

Type	Gear driven
Number of teeth:	
Drive gear	24
Intermediate gear	57
Diameter:	
Hub, intermediate gear	69.99 ± 0.0095 mm (2.76 ± 0.0003 in)
Bushing, intermediate gear	70.044 ± 0.019 mm (2.76 ± 0.0007 in)
Axial clearance:	
Drive gear, pump	0.110 mm (0.0043 in)
Intermediate gear	0.100 mm (0.0039 in)
Backlash	0.05–0.17 mm (0.002–0.007 in)

Oil Filters

Number	3
Full-flow filter	2
Bypass filter	1

Oil Valves

1. Reduction valve

Marking	Brown

2. Overflow valve, oil cooler

Marking	Green
Thermostat valve, total length	40.1 mm (1.6 in)

3. Overflow valve, oil filter

Free length	68.8 mm (2.7 in)
With load of 13–15 Nm (1.3–1.5 lb-ft)	40.0 mm (1.6 in)

4. Piston cooling valve

Marking	Orange

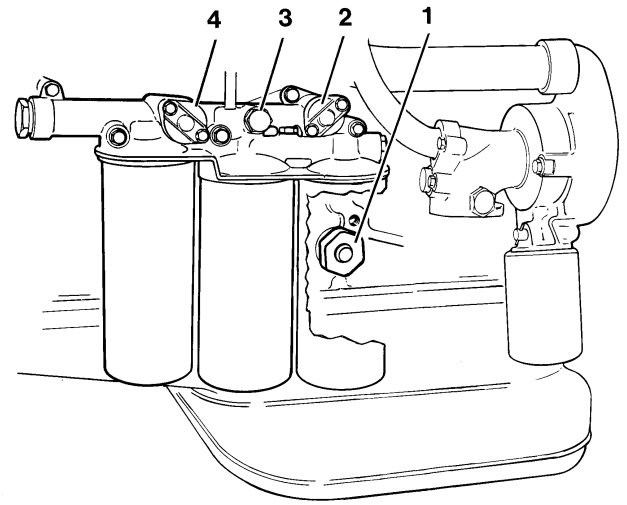

Fig. 11: Lubricating system

Fuel System

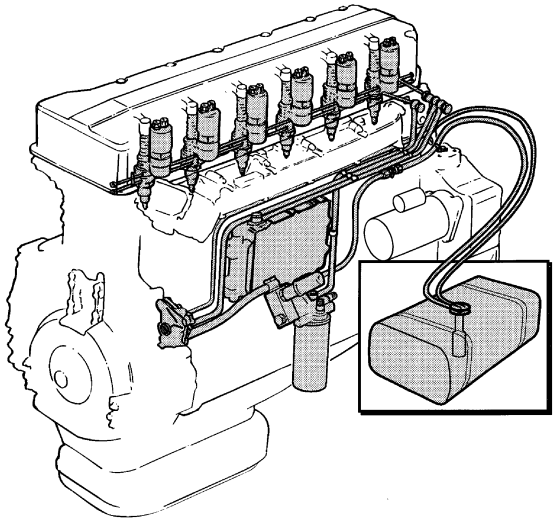

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Fig. 12: Fuel system

Fuel Pump

Fuel pressure	300–350 kPa (43.5–50 psi)

Electronic Unit Injectors

Pre-load setting	0.75 mm (0.0295 in)

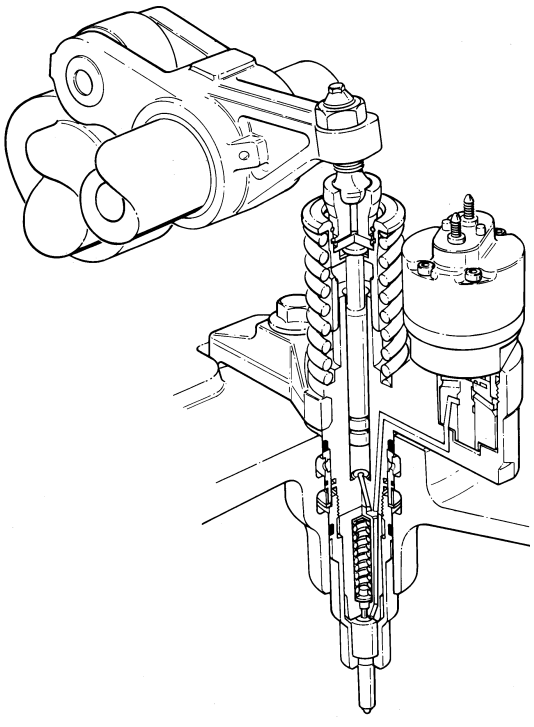

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Fig. 13: Electronic unit injector

Cooling System

Type	Pressurized
Pressure valve opens at	75 kPa (10.9 psi)

Coolant

Antifreeze with corrosion protection meeting or exceeding ASTM D 4985 standard as a minimum.	
Color	Blue-green

Coolant Filter

Number	1

Anti-corrosion Additive

CAUTION
Do not mix anti-corrosion additive with concentrated coolant or any other type of anti-corrosion fluid. Doing so may cause damage.

Water Pump

Type	Gear-driven centrifugal pump

Thermostat

Type	Plunger
Opening temperature, standard	86°C (187°F)

Wear Tolerances

Cylinder Head

Cylinder head should be replaced if the maximum deviation on the flat surface (bottom face) is 0.2 mm (0.0079 in) or greater.

Cylinder Liner

Cylinder liners (pistons and piston rings) should be replaced with a wear of 0.45–0.50 mm (0.018–0.019 in) or if oil consumption is abnormally high.

Crankshaft

Maximum allowable out-of-round on main and connecting rod bearing journals	0.08 mm (0.003 in)
Maximum allowable taper on main and connecting rod bearing journals	0.05 mm (0.002 in)
Maximum axial clearance on crankshaft	0.40 mm (0.015 in)
Maximum throw on central journalling	0.15 mm (0.0059 in)

Connecting Rods

Straightness, maximum deviation on a measuring length of 100 mm (3.9 in)	0.06 mm (0.0024 in)
Warp, maximum deviation on a measuring length of 100 mm (3.9 in)	0.15 mm (0.0059 in)

Valves

Valve stem, maximum allowable wear on diameter	0.010 mm (0.00039 in)
Maximum allowable clearance between valve stem and valve guide:	
Intake	0.2 mm (0.008 in)
Exhaust	0.3 mm (0.012 in)
Valve disc edge should be minimum:	
Intake	1.4 mm (0.06 in)
Exhaust	1.2 mm (0.05 in)
Valve seat may be ground down as long as the distance from valve disc (new valve) to cylinder head face does not exceed:	
Intake	1.5 mm (0.06 in)
Exhaust	1.8 mm (0.07 in)
If distance exceeds specification, replace the valve seat.	

Camshaft

Maximum allowable out-of-round (bearings)	0.01 mm (0.0004 in)
Bearings, maximum allowable diametrical wear	0.01 mm (0.0004 in)
Cam profiles, allowable wear:	
Intake	0.2 mm (0.008 in)
Exhaust	0.2 mm (0.008 in)
Engine brake (VEB)	0.1 mm (0.004 in)
Unit injectors	0.1 mm (0.004 in)

Tightening Torques

Component	Nm	lb-ft
Main bearing cap bolts Step 1	150 ± 20	111 ± 14
Main bearing cap bolts Step 2	Turn an additional 120° ± 5°	
Connecting rod bearing cap bolts	252 ± 12	186 ± 9
A/C compressor bolts	48 ± 8	35 ± 6
Fuel feed pump bolts M8	33 ± 4	24 ± 3
Fuel feed pump bolts M10	48 ± 8	35 ± 6
Starter mounting bolts	85 ± 15	63 ± 11
Power steering pump bolts	48 ± 8	35 ± 6
ECU mounting bolts	33 ± 4	24 ± 3
Timing gear plate bolts M8	33 ± 4	24 ± 3
Timing gear cover bolts M10	48 ± 8	35 ± 6
Timing gear cover bolts M12	85 ± 15	63 ± 11
Timing gear cover bolts M14	140 ± 12	103 ± 10

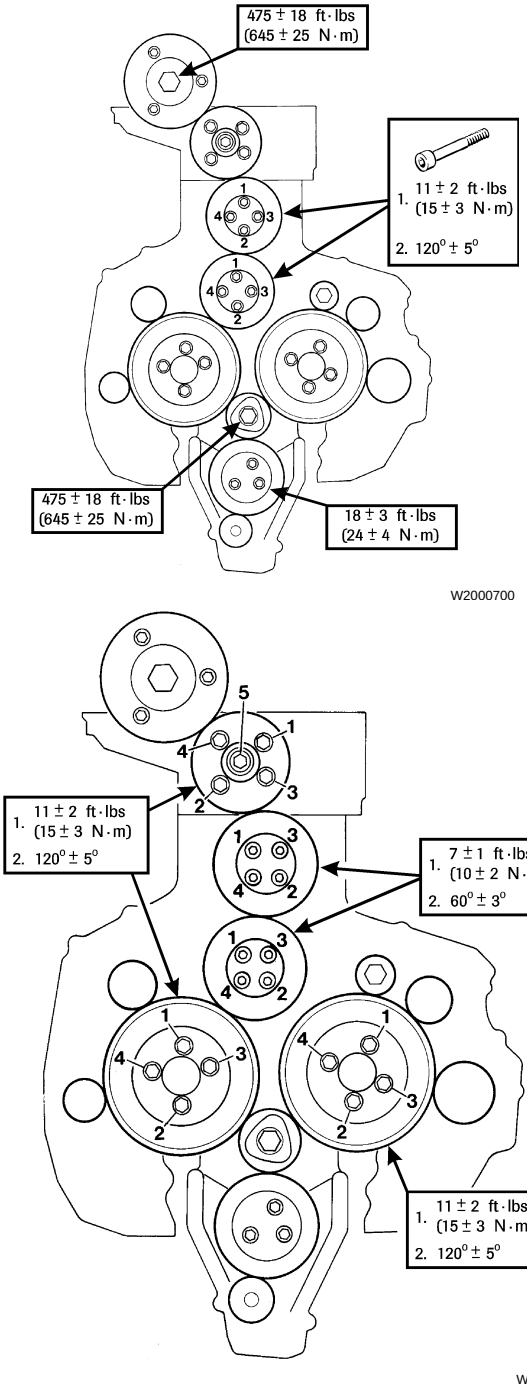

Fig. 14: Torque sequences for timing gears

Component	Nm	lb-ft
Oil pan bolts	24 ± 4	18 ± 3
Drain plug, oil pan	60 ± 15	44 ± 11
Oil pump bracket bolts	24 ± 4	18 ± 3

Note: First tighten the bolts marked **X**, then tighten the remaining bolts.

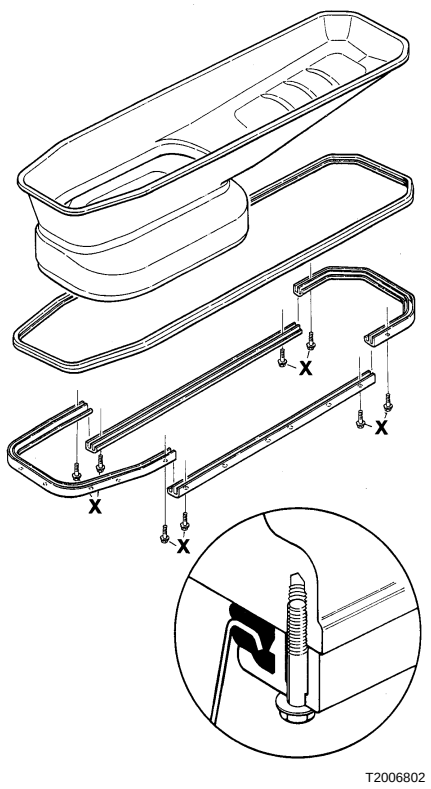

Fig. 15: Tightening sequence for oil pan bolts

Component	Nm	lb- ft
Cylinder head bolts, Step 1	60 ± 10	44 ± 7
Cylinder head bolts, Step 2	Turn an additional 90° ± 5°	
Cylinder head bolts, Step 3	Turn an additional 90° ± 5°	

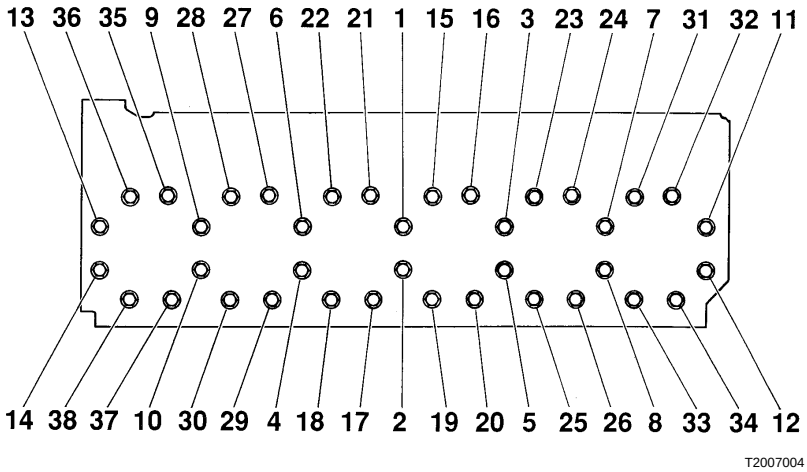

Fig. 16: Tightening sequence for cylinder head bolts

Component	Nm	lb-ft
Flywheel housing bolts	140 ± 14	103 ± 10
Flywheel bolts, Step 1	85 ± 5	63 ± 4
Flywheel bolts, Step 2	Turn an additional 30° ± 3°	
Retainer bolt, unit injector with **new copper sleeve**		
First tightening, Step 1	20 ± 5	15 ± 4
First tightening, Step 2	Turn an additional 180° ± 5°	
Note: Loosen the retainer bolt for the unit injector prior to the second tightening		
Second tightening, Step 1	20 ± 5	15 ± 4
Second tightening, Step 2	Turn an additional 60° ± 5°	
Retainer bolt, unit injector with **old copper washer**		
Step 1	20 ± 5	15 ± 4
Step 2	Turn an additional 60° ± 5°	

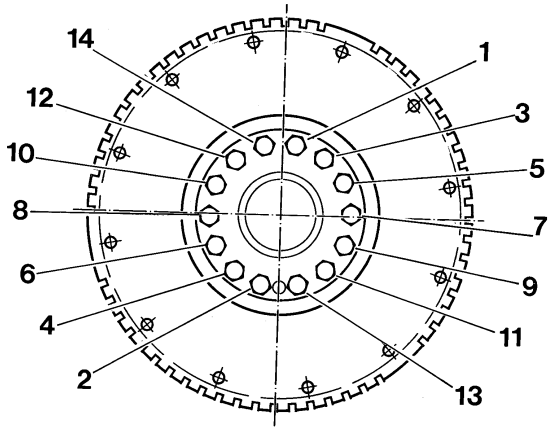

Fig. 17: Tightening sequence for flywheel bolts

Component	Nm	lb-ft
Valve cover nuts	30 ± 3	22 ± 2
M14 engine mounting bolt	140 ± 25	103 ± 18

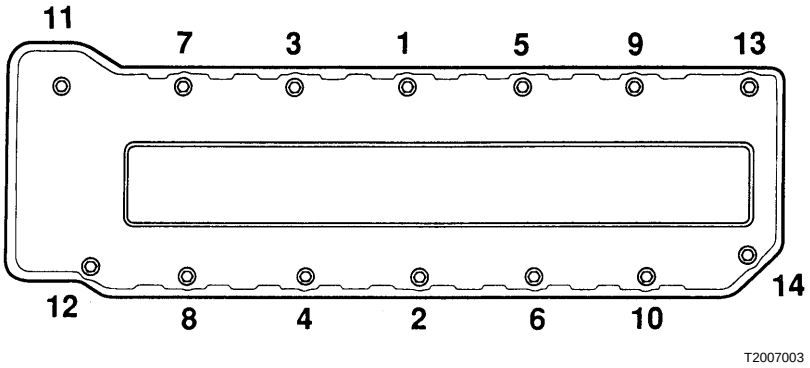

Fig. 18: Tightening sequence for valve cover bolts

Component	Nm	lb-ft
Exhaust manifold bolts	48 ± 8	35 ± 6
Intake manifold bolts	33 ± 4	24 ± 3
Vibration damper bolts	50 ± 5	37 ± 4
Piston cooling nozzle bolt	24 ± 4	18 ± 3
Cleaning plugs, cylinder head (M38 x 1.5)	60 ± 10	44 ± 7
Valve cover stud (Loctite)	48 ± 8	35 ± 6
Oil cooler mounting bolts	27 ± 4	20 ± 3
Oil strainer mounting bolts (in pump)	27 ± 4	20 ± 3
Valve adjustment locknut	38 ± 4	28 ± 3
Nut, unit injector electrical connection	1.4	1

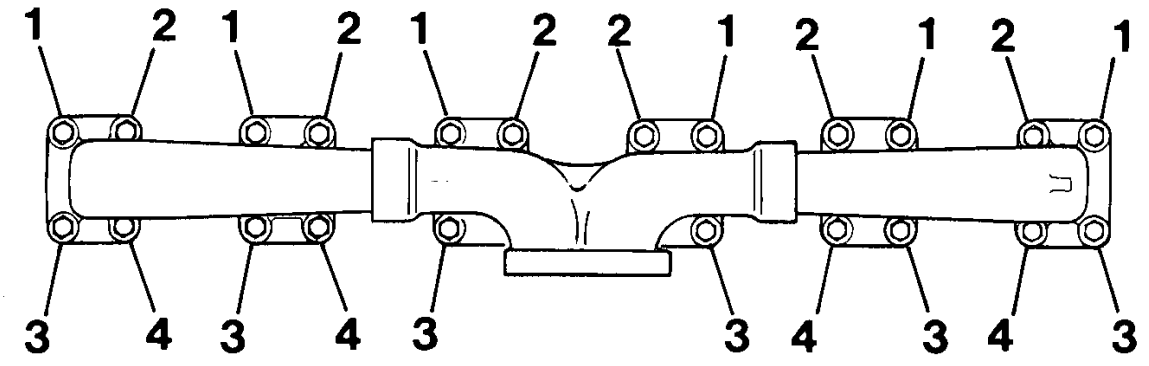

Fig. 19: Tightening sequence for exhaust manifold bolts

When reinstalling a rocker arm shaft that has been loosened or removed, torque only the bolts holding the shaft, according to the diagram.

Note: Loosen the marked bolts in step 8 before proceeding to steps 9 and 10.

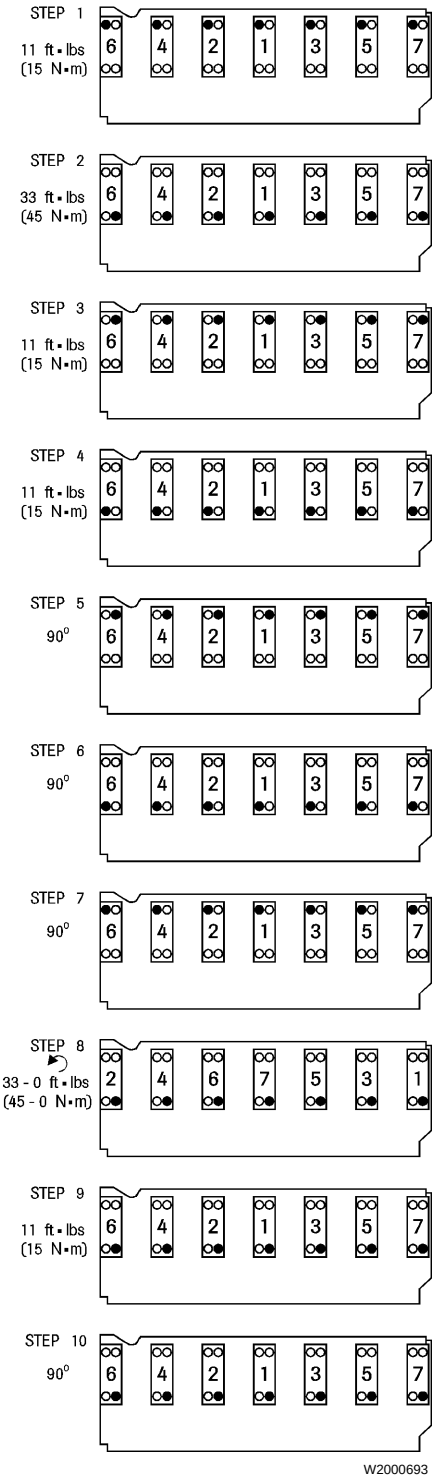

Fig. 20: Torque values and procedure for camshaft housing bolts

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